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Rocky road ahead for fast pyrolysis

THE SCIENCE behind creating liquid fuel from biomass using fast pyrolysis techniques is gathering momentum, but project developments face a rocky road, as Andrew Mourant reports.

Bronze age man knew little of the science, yet, in producing the wood-based charcoal he needed to smelt tin and copper, he had an instinctive understanding of pyrolysis - the process by which biomass changes composition when heated in an oxygen-free environment.

During the last 30 years researchers and businesses globally have been studying the commercial potential. In the UK, academics at the **University of Aston** have focused on fast pyrolysis - at temperatures around 500°C and with short reaction times - rather than at the 200-300°C commonly used in creating charcoal. The science is hotting up.

Through fast pyrolysis, liquid fuel is produced from biomass that can be easily transported then further processed for heat, power, biofuels, and chemicals. Techniques developed in Italy and Germany using wood or rape

seed as a feedstock have yielded fuels that drive combined heat and power (CHP) engines. France and the United Kingdom have tended to favour using pyrolysis liquids in petro refineries.

Scientists at the **European Bioenergy Research Institute (EBRI)** at Aston University have concentrated on a pyrolysis technique at reaction temperatures of around 450 - 500°C. This produces liquid, gas and char, with vapours passed directly to a gasifier. The feedstock can be in any form and size - for instance chips, pellets or powder - and the end product used directly for combined heat and power engines.

Rocky road

But while the science and its possibilities are becoming better understood, plans for some commercial operations have had a bumpy ride.

In 2010, *Renewable Energy Focus* reported on a collaboration involving **Tolko Industries Ltd**, a Canadian forest products company with manufacturing operations across Western Canada, and **Ensyn**. The partners had planned to build the world's largest commercial fast pyrolysis plant in High Level, Alberta.

It was projected to cost \$80mn and process 400 dry tonnes of biomass every day into 85mn litres of pyrolysis oil annually. It was meant to start running this year and yield renewable electricity and heat that would be used in Tolko's sawmill at High Level.

With Ensyn claiming to be the world leader in fast pyrolysis and producing oil from forestry biomass - they've been doing it since 1989 - it was hard to imagine anything going wrong. But it did, as Michael Towers, Tolko's energy supply and systems manager, explained to REFocus. "Despite significant government funding and other contributions, the project was not economic due to escalation of capital costs from the outset and a drop in Alberta electricity rates," he said.

"Over \$1million was spent in the engineering feasibility studies and development before Tolko and Ensyn jointly deciding it was not economically viable.

"When it became apparent that producing power from pyrolysis oil wouldn't be feasible, the two parties explored the possibility of pyrolysis sales to industrial facilities using fuel oil for thermal energy. This, unfortunately, also proved not to be economically viable, primarily because the High Level site is too far from existing markets."

The project appeared to have ticked all the boxes and attracted a \$5mn grant from the Alberta provincial government's Climate Change and Emissions Management Corp, (CCEMC). Its demise followed quite swiftly. "We announced our support in June, 2011 and by January 2012 were aware it was not proceeding," said CCEMC spokeswoman Celia Sollows.

Meanwhile another ambitious project in Hawaii - being driven by **Honeywell's UOP** - is facing an unwelcome complication. Backed by



About: Andrew Mourant is a freelance journalist whose specialisms include renewable energy, education and the rail industry

a \$25mn award from the **US Department of Energy** to build an integrated biorefinery in Kapolei, Honeywell planned a demonstration unit that would convert forest waste, algae and other biomass into liquid biofuel for upgrading into gasoline, diesel and jet fuel.

It picked a site alongside the **Tesoro Corp** refinery with the intention of being fully operational by 2014. Jim Rekoske, vice president and general manager of renewable energy and chemicals for Honeywell's UOP, has anticipated that once in full flow the plant could produce up to 50mn gallons of green transportation fuels a year and create 1000 new jobs.

But in January 2013, Tesoro announced that its Oahu refinery, which makes jet fuel, gasoline, diesel, and bunker fuel for Hawaiian Electric Company, will close in April. That's created a headache for Honeywell as it has relied on services provided by Tesoro in developing its own refinery.

Honeywell is still digesting the implications; though remains publicly upbeat about fulfilling its mission. "To date our project is tracking toward a 2014 completion date," said company spokeswoman Krystal Hughes. "We're working closely with Tesoro, the US Department of Energy and other stakeholders to determine any potential effects. But based on what we currently know, we believe the project will continue as planned. We're fully committed to the integrated biorefinery."

Meanwhile Holland, already taking the lead in developing torrefaction as a source of renewable energy (see *Renewable Energy Focus*, January/February 2013, page 42-45) is also working on business possibilities for pyrolysis. Last September, **Biomass Technology Group (BTG)**, which has 30 years experience of developing biofuels, took a new step forward by producing pyrolysis oil for gasification from its pilot plant in Enschede. The final stage, gas production, actually took part at the Sweden-based **Energy Technology Centre**, a not-for-profit research institute in Piteå that works with industry and academics on combustion and gasification.

Future plans include carrying out the process on a single site, converting

pyrolysis oil feedstock to synthetic end-products such as methanol, Fischer-Tropsch diesel or Dimethylether. The intention is to use catalytic reactors developed jointly by **Brunel University**, London and **IMM** in Germany.

International co-operation in sharing and exploiting pyrolysis technology has become routine: the SUPRABIO project, which aims to create sustainable products from biomass processing in integrated refineries, involves 16 European organisations and has financial backing from the **European Commission**.

BTG has also embarked on a pyrolysis collaboration with the chemical industry giant **AkzoNobel**, which wants to cut its heavy dependency on fossil fuel. The initiative has drawn in eight partners from Holland, Germany, and Denmark, involved in various aspects of the technology and biomass supply. The pyrolysis plant will be next to AkzoNobel's plant in Hengelo and, to be economic, must be capable of processing at least 100 tonnes of biomass daily.

Energy recovery

But converting biomass isn't the only method of producing fuel through pyrolysis. **Enval**, a privately funded company originally spun-out from the **Cambridge University's department of chemical engineering**, is about to launch its first commercial scale microwave-induced pyrolysis system for recovering energy and materials from packaging that contains aluminium.

Based at a former US airforce base at Alconbury, near Huntingdon, Enval hopes to show off its technology as a commercial proposition to the waste handling industry this month (March 2013). It uses unpromising raw material that's long been impossible to recycle and ended up as landfill fodder – laminated material such as pet food pouches, fruit juice packs and tooth-paste tubes.

Enval is moving fast after securing premises on what has now become an enterprise zone. Multi-national brand owners **Nestle**, **Kraft Foods** and **Mondelez International** have helped fund the plant, though they have not taken any stake in the company itself, says

Enval business development director David Boorman.

The technology separates waste material into constituent components, producing clean aluminium ready for introduction into the supply chain and hydrocarbons that can be used as fuel for energy recovery or chemical feedstock. The company says that 100% of the aluminium and plastics can be extracted this way.

The polymer element is processed into gas after passing through a series of condensers. Enval has already given customer demonstrations at its pilot plant in Luton and claims it takes 95% less energy to produce secondary aluminium through recycling than primary aluminium from bauxite.

The operation itself is remarkably compact – 'the kiln about the size of a small family car; the premises the size of two freight containers', says Boorman. "Because it's microwave-induced pyrolysis and we aren't burning fossil fuel, we don't need a flue or chimney. We use the gases produced to generate electricity that powers the microwave." Enval claims the entire process is carbon neutral.

Boorman is reluctant to discuss any specifics of funding or costs, or how many the company employs, revealing only that Enval has had backing from 'angel investors in Cambridge and further afield', and the **UK Technology Strategy Board**.

What is the long term plan? "We don't see ourselves becoming waste handlers but manufacturing plants for the waste handling industry – that's our business model," says Boorman. "Our target markets include local councils and paper mills that import cartons from which they take the paper off but leave behind the aluminium content."

Council waste sites could prove to be a rich source of raw material, even black bin bags full of putrid household waste, for invariably these contain material that people have neglected to recycle.

"We're also looking at other products we can process, and targeting markets around the world," adds Boorman. "I wouldn't say the market is infinite but it is significant."